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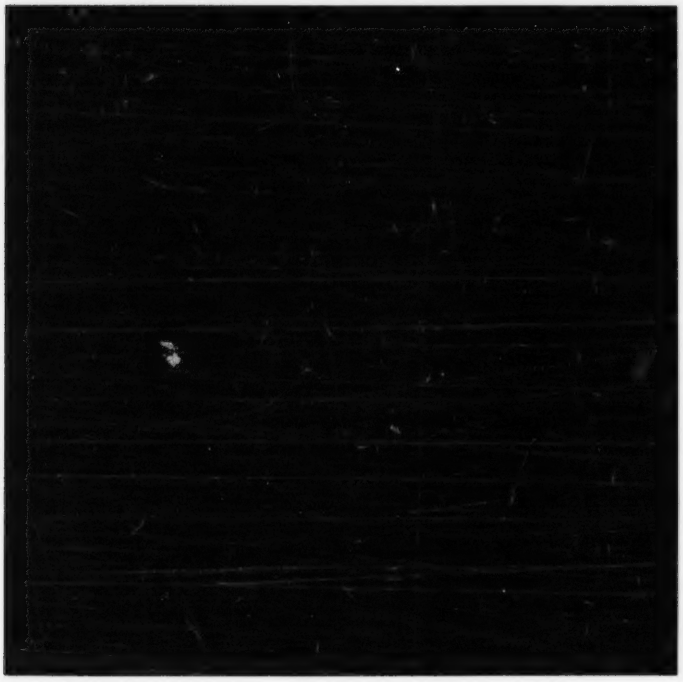
# EFFECTS OF AERIAL APPLICATION OF THE HERBICIDE, ROUNDUP, ON FOREST ECOSYSTEMS: PART 1 PROCEDURES MANUAL



Canada

Manitoba

# EFFECTS OF AERIAL APPLICATION OF THE HERBICIDE, ROUNDUP, ON FOREST ECOSYSTEMS: PART 1 PROCEDURES MANUAL

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Department of Environment and Workplace
Safety and Health

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## ABSTRACT

A three-year research program was initiated in the spring of 1985 to study the direct effects of aerial application of the glyphosate herbicide, Roundup, on target and nontarget vegetation in the boreal forest region of southeastern Manitoba. Because the indirect effects of Roundup on wildlife utilization of this habitat is of prime concern, the project included studying wildlife responses to habitat changes induced by Roundup.

Four study areas, two control and two treated, were selected in April 1985. Assessment procedures using both botanical and wildlife parameters were established. This report describes the methods employed.

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## 1. INTRODUCTION

Glyphosate [N-(phosphonomethyl)glycine] is a foliar applied herbicide that is sold under the brand name, Roundup. It kills the entire plant because it is rapidly translocated from the foliage to the roots, rhizomes and apical meristems (Franz, 1985; Parochetti et al, 1975). Also, Roundup is broad-spectrum, nonselective and post-emergent. These qualities make Roundup attractive to forest companies for the management of undesirable vegetation during reforestation.

Roundup is applied (usually aerially) as a site preparation tool to control herbs, shrubs and hardwoods which would compete with the conifer seedlings for light, moisture and nutrients. Once the plantations are established, the competing vegetation is selectively controlled by "touch-up" applications (Newton et al, 1984).

Abitibi-Price Inc. (Pine Falls) claims that without the use of a herbicide such as Roundup, most of their reforestation efforts would fail. Aspen suckers are stimulated to grow quickly in the ideal conditions left after logging. If Abitibi-Price did not intervene, pure hardwood stands would result; these have no economic value as lumber or pulpwood (H. Peacock, pers. com. 1985). Manual control methods are inefficient and costly, thus the need for an effective herbicide which has no long-term effects on the environment.

Most research information on Roundup indicates it is a safe chemical and its effects are shortlived. It binds tightly to the soil particles and is readily metabolized by micro-organisms; resulting end products are phosphoric acid, ammonia and carbon dioxide (Rueppel et al, 1977; Sprankle et al, 1975).

There is little information on the consequence of aerial application of this herbicide on boreal forests in Manitoba. This study's objective is to examine glyphosate's direct effect on vegetation and how it indirectly influences the utilization of the habitat by wildlife (song birds, small mammals and ungulates). The fate and distribution of the herbicide is also to be monitored.

## 1.1 Study Region

The study region, Sandy River West, is located 3.5 km west of Provincial Road 304 and north of Sandy River, in sections 27, 28 and 33 of township 23, range 9E. The control area is located 2.2 km northwest of the Sandy River crossing and the treated area is .5 km to the northeast (Figure 1). In each area, plots were selected in two forest types: a cut-over burn and a stand of young aspen. For simplicity, the names of the sites were abbreviated to initials (Table 1).

The cut-over area had been burned in 1984 and shear bladed by Abitibi-Price the following winter. Black spruce [*Picea mariana* (Mill.) BSP.] seedlings were planted in the summer of 1985.

Table 1: Study Site Characterization

| Name | Initials |
|---|---|
| Treated Aspen | TA |
| Treated Burn | TB |
| Control Aspen | CA |
| Control Burn | CB |

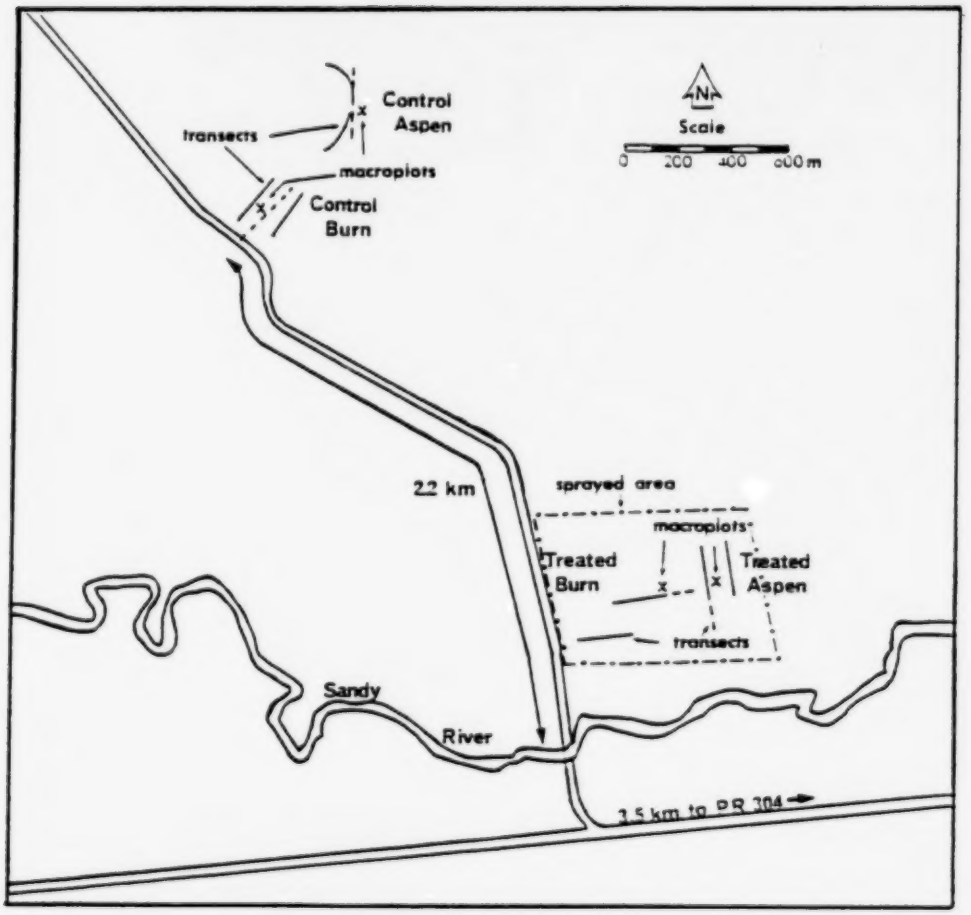
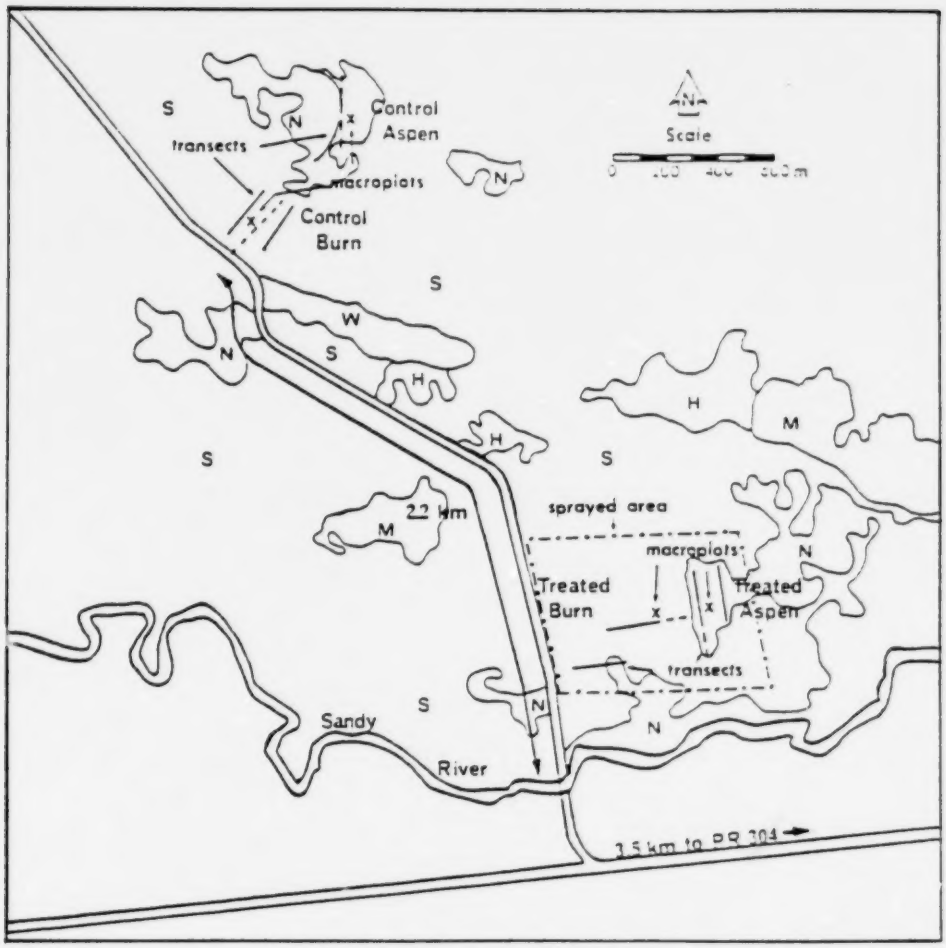



Figure 1: Map indicating the relative locations of the four study sites at Sandy River West.

## 1.2 Vegetation

According to the Provincial Forest Inventory (1980) (Figure 2), the burn area had been a softwood forest with white spruce [Picea glauca (Moench) Voss] dominating (71% to 100%). Today, there are scattered residual stands of spruce and small clumps of willow and aspen. The dominant shrub species are willow, rose (Rosa acicularis Lindl.), and raspberry (Rubus idaeus L.). The predominant ground cover species other than grasses, are northern bedstraw (Galium boreale L.), strawberry [Fragaria glauca (S. Wats.) Rydb.], Lindley's aster (Aster ciliolatus Lindl.), and thistles.

The aspen stand was chosen to represent the typical NSR areas which are being reforested by Abitibi-Price. It is a hardwood/softwood mixedwood forest dominated (60%) by trembling aspen (Populus tremuloides Michx.) (Provincial Forest Inventory, 1980); black and white spruce, balsam fir [Abies balsamea (L.) Mill.], tamarack/larch [Larix laricina (DuRoi) K. Koch], and white birch (Betula papyrifera Marsh.) are the other major tree species. The shrub understory consists primarily of rose, high bush cranberry (Viburnum trilobum Marsh.), raspberry, saskatoon (Amelanchier alnifolia Nutt.), hazel (Corylus cornuta Marsh.), and species of plum. Northern bedstraw, wild Lily-of-the-valley (Maianthemum canadense Desf. var. interius Fern.), Lindley's aster, grasses, and strawberry constitute the major ground cover species.




Source: Provincial Forest Inventory (1980)

LEGEND

H Hardwood

M Softwood-Hardwood Mixedwood

N Hardwood-Softwood Mixedwood

S Softwood

W Willow

Figure 2: Forest cover map of Sandy River West.

## 1.3 Soils

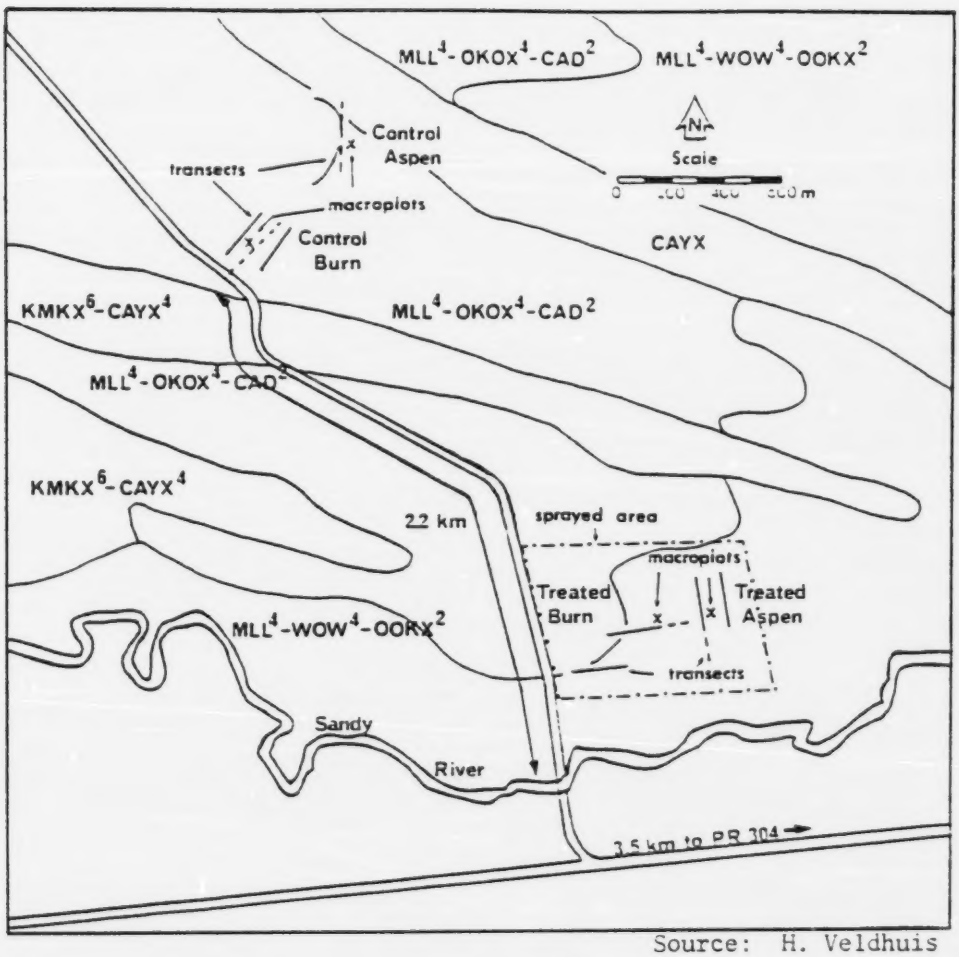
Sandy River West is within the Precambrian Shield and is underlain by granitoid bedrock (Barr, 1956). Soil texture is generally heavy ranging from silty clay to clay (Barr, 1956). Granite rock outcrops are an outstanding characteristic of this area (Ellis, 1938). Drainage ranges from poor to well-drained and the topography is gently sloping with occasional depressional flats and basin bogs (H. Veldhuis, pers. com. 1986).

The soil types at the control and treated plots are very similar (Figure 3). The soil at the treated sites belongs to the Malloy Series/Wanipigow River Series/Orok Complex of clay and fibric peat. The organic soil is shallow with a thin layer of fibric sphagnum peat over a mesic forest peat. Calcareous, clayey, stone-free lacustrine sediments underly the peat (H. Veldhuis, pers. com. 1986).

The control sites have soils that are classified Malloy Series/Okno Complex/Caddy Lake Series. The organic soil is shallow with a discontinuous thin layer of fibric sphagnum peat at the surface and mesic forest peat below. A veneer of lacustrine sediments overly the rolling bedrock (H. Veldhuis, pers. com. 1986).

## 1.4 Climate

Total annual precipitation is 588.9 mm; most of it falls as rain from May to September. January is the coldest month with a mean daily temperature of -20.9°C and July is the warmest, at 18°C (Environment Canada).




Source: H. Veldhuis

LEGEND

| | |
|---|---|
| CAYX | Cayer Complex (mesic peat) |
| $KMKX^{6}$-$CAYX^{4}$ | Katimik Complex (mesic peat); Cayer Complex (mesic peat) |
| $MLL^{4}$-$OKOX^{4}$-$CAD^{2}$ | Malloy Series (clay); Okno Complex (mesic peat); Caddy Lake Series (clay) |
| $MLL^{4}$-$WOW^{4}$-$OOKX^{2}$ | Malloy Series (clay); Wanipigow River Series (clay); Orok Complex (fibric peat) |

Figure 3: Soils map of Sandy River West.

### 1.5 Herbicide Application

The treated areas were sprayed with Roundup by fixed wing aircraft on the evening of August 16, 1985, at an application rate of 2.5 L/ha. Results from the analysis of the vegetation, soil and deposition samples, and the vegetation damage assessment indicated that the herbicide had little, if any, effect. At the time of spraying the foliage was wet. This, combined with the heavy rain that started six hours later and continued for over 24 hours, could have caused the herbicide to drip from the foliage. Caseley and Coupland (1985) found that the amount of moisture (dew or rain) on the leaf surface at application time is crucial as it can induce runoff of the herbicide.

The treated plots were resprayed on August 15, 1986, at the same application rate. The spraying occurred in the early morning on a clear, calm day; light rain fell in the late afternoon. It is hoped that the herbicide was absorbed into the foliage before the rain.

Safety equipment, including disposable coveralls, gloves and respirators, was worn by all persons who conducted immediate post-spray sampling.

## 2. PROCEDURES

### 2.1 Vegetation Assessment

In each of the four areas, one 10 m x 10 m plot was set up to study the tree and shrub strata. All trees and shrubs were identified, tagged and the height and diameter measured. To document the density, cover and frequency of the herbaceous and ground layers, ten 1 $m^2$ microplots were randomly located in each macroplot.

Cover is defined as the percentage of the total area covered by the aerial parts of the plants (Greig-Smith, 1983). It was estimated using a modified Braun-Blanquet Cover-Abundance Scale (Table 2). Density is the number of plants per $m^2$ and frequency is the percentage of microplots in which each species occurs (Greig-Smith, 1983).

Data on vegetation abundance was collected twice in both 1985 and 1986: once in July, before spraying, and again in September, two weeks after the application. Two weeks was the minimum time lapse required to see the results of the herbicide (Bingham et al, 1980). The vegetation will be examined again in July 1987.

Table 2: The modified Braun-Blanquet Cover-Abundance Scale used to estimate cover of vegetation at Sandy River West (Mueller-Dombois and Ellenberg, 1974).

| Scale | Percent Cover |
|---|---|
| 1 | 0 ≤ 1 |
| 2 | > 1 ≤ 10 |
| 3 | > 10 ≤ 25 |
| 4 | > 25 ≤ 50 |
| 5 | > 50 ≤ 75 |
| 6 | > 75 ≤ 90 |
| 7 | > 90 ≤100 |

## 2.2 Vegetation, Soil and Deposition Sampling

Sampling sites were located on each of the four sides of each macroplot and were permanently marked with 2 cm x 4 cm stakes. The sites were sampled four times with respect to the 1985 application: pre-spray (July 1985), immediate post-spray (August 1985), 30-day post-spray (September 1985), and 10-month post-spray (June 1986). The same sampling regime will be carried out for the 1986 application.

All samples for glyphosate residue analysis were stored in plastic 500 g honey containers. The containers were rinsed with acetone and hexane and dried in a fume hood. After being sealed, they were labelled with plot name, site, sample, and date information.

Vegetation samples were collected from aspen, rose and ground cover at the aspen sites but only from willow and ground cover at the burn sites. In the case of the aspen and willow, all leaves were removed from an imaginary vertical column through the plant's crown (Figure 4). All leaves were collected from the rose bushes and all ground plants were removed from a 400 $cm^2$ area.

Soil samples were taken from three levels: the surface organic layer, and 10 cm and 30 cm depths. Soil pits were dug to a depth of 40 cm and one side was trimmed vertically for sampling. A 10 cm x 10 cm plastic template was used to standardize the area of each soil sample at 100 $cm^2$. The template was placed on the soil surface and a sharp knife was used to cut around it. The resulting square of surface organic soil was separated from the mineral soil and placed in a sample container. Mineral soil was then removed to the

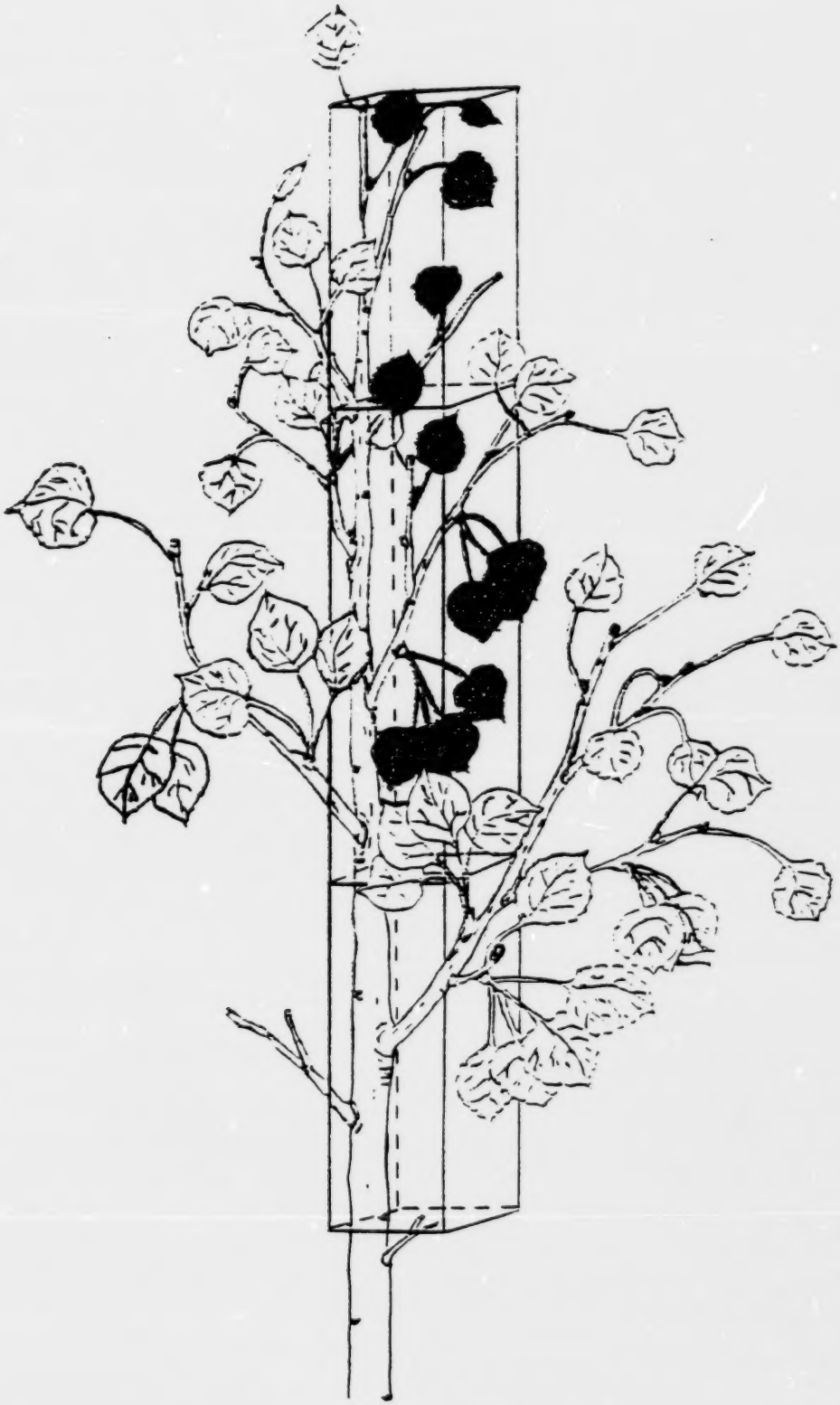


Figure 4: Diagram showing foliage sampling for aspen and willow. Shaded leaves were sampled.

10 cm depth and a 2 cm x 10 cm x 10 cm sample was taken at this depth. The latter technique was used to expose and remove the 30 cm sample (Figure 5). Trowels and spades were cleaned between sampling to prevent contamination.

Deposition was monitored above the tree canopy and at ground level using 20 cm x 20 cm mylar sheets which were exposed during the spraying. The mylar was attached to a mounting board (a square of particle board) with plastic tacks. The mylar and tacks were pre-cleaned by rinsing with acetone and hexane. To sample at the top of the tree canopy at the two aspen sites, the mounting board was screwed onto ABS joints and extended into the air by joining four sections of 3.8 cm (1 1/2 in) ABS pipe. Duct tape was wrapped around the couplings to hold the pipes together while three guy ropes tied to trees kept it upright. Each section of pipe was 1.2 m (4 ft) long and allowed the device to be dismantled quickly section by section. At the same time, tightening the guy ropes maintained the particle board and mylar in a horizontal position so that no Roundup residue could be lost. Spray deposition at ground level was monitored by placing the mylar attached to the mounting board close to but not under the tree samplers. Only ground level deposition was sampled at the burn sites.

All samples were frozen quickly with dry ice and transported in coolers to a freezer in Winnipeg. Samples were wrapped in newspaper and packed in dry ice while being shipped to A & S Environmental Testing, Temple, PA, USA, for analysis.

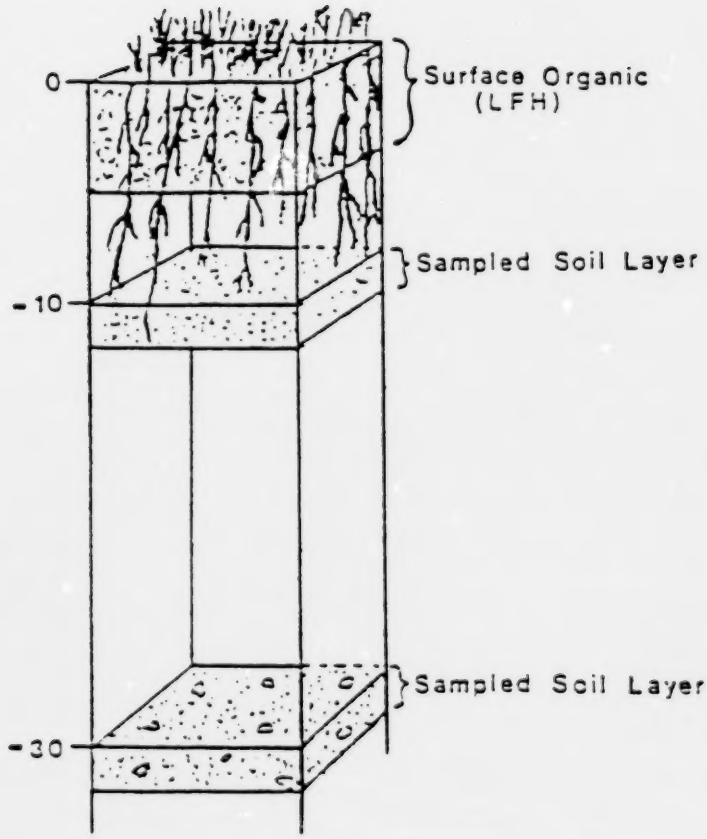



Figure 5: Diagram showing soil profile sampling

2.3 Bird Surveys

In each study area fixed width (100 m) transects were established to census the breeding bird population. The transects were laid out using a compass to keep the lines straight. Blue flagging was tied on trees or shrubs every 12.5 m and orange flagging, every 50 m, marked the recording stations. Vegetation was cut back in the aspen sites to facilitate movement along the trails (Dawson, 1981).

Two parallel lines, totaling 500 m in length and 100 m apart, were established at each treated site (Franzreb, 1981; Huff et al, 1984). At each control site only one transect line (250 m) was set up; large areas of homogenous vegetation were not available.

Trial runs were conducted with the help of a knowledgeable bird expert and thirteen birds were chosen as indicator species (K. DeSmet and D. Busby, pers. com. 1985). The surveys were run during the second and third weeks of June between the early morning hours of 5:00 and 8:30 (Bull, 1981; Dawson, 1981a; Huff et al, 1984; Mikol, 1980; Robbins, 1978 & 1981a). Each transect was done five times and at different times each morning.

The observers walked between stations pausing for two minutes at each one to listen for any auditory signals (Bond, 1957; Reynolds et al, 1980). Only those birds in front of the observers and within the 50 m limit on either side of the line were recorded (Franzreb, 1981; Dawson, 1981a; Robbins, 1978; Scott & Ramsey, 1981). Bird sounds were tape recorded for a minute with a Soni TCM-737 cassette recorder fitted with a parabolic reflector. Recording time had to be limited to one minute because after that so many insects had converged

on the observers that the bird songs were drowned out by insect sounds. The approximate locations of the birds were noted on a map of the transect (Mikol, 1980). Survey start and finish times, weather conditions and the bird's activity were recorded on data sheets. Because high winds, heavy rains or cold temperatures could affect the quality of the observations as well as the behavior of the birds, surveys were not conducted when those conditions prevailed (Dawson, 1981a).

## 2.4 Small Mammal Trapping

Permanent traplines were established at each study area, consisting of two parallel lines, 200 m long and 100 m apart. Trapping stations were located at 10 m intervals and were marked permanently with stakes. Each stake was labelled with the line letter, A or B, and the station number. Because of the narrow configuration of the aspen stand at the Control Aspen site, the two lines were run consecutively with 20 m between the end of line A and the beginning of line B.

Each trap was attached to the stake with a 0.8 m long string allowing it to be set anywhere within the 2 $m^2$ circular area (Pruitt, 1968). Attaching the traps to the stakes also prevented the traps from being carried off by birds or animals. Traps were placed in strategic locations such as along runways, or near a hole, rock or stump. The bait was a mixture of peanut butter, rolled oats and bacon bits.

Three traps were set out at each station and were checked once a day. The traplines were maintained for three consecutive days and nights for each sampling event. Sampling took place three times both in 1985 and 1986: in early August, mid-August and mid-September. These dates corresponded to pre-spray, immediate post-spray and 30-day post-spray, respectively.

The rodents were stored in plastic bags marked with the date, plot initials and station identification number (i.e.: 16/8/86 TA A6). The carcasses were kept on ice in a cooler until they were returned to Winnipeg where they were stored in a feezer until they could be identified.

In 1987, trapping will occur only twice corresponding to the pre-spray and 30-day post-spray time periods. These times are important as the former occurred before any spraying took place and the latter time is after the breeding season which is the best time to determine actual numbers (S. Mihok, pers. com. 1986).

## 2.5 Ungulate Studies

Fifty 2 m x 2 m plots were established at each study area to determine preferred browse and to monitor any difference in the degree and extent of browse between control and treated plots. Preferred browse by stem count will be calculated using Telfer's (1972) preference factor equation. Also, the number of pellet groups found in these plots will be recorded and, based on the defecation rates per day for each animal, the use of the habitats by moose and white-tailed deer will be calculated (H. Hristienko, pers. com. 1985). The plots

were established along the small mammal trapline and permanent stakes were used to mark the corners of each plot. Meter sticks were permanently mounted at 50 m intervals to register snow depth (H. Hristienko, pers. com. 1985).

At the beginning of October, 1985 and 1986, the plots were prepared for estimating winter habitat and browse utilization. This involved removing all pellet groups and counting the total number of stems and number of browsed stems between the heights of .3 m (1 ft) and 2.1 m (7 ft). Six primary browse species were included in the study: willow, red-osier dogwood (Cornus stolonifera Michx.), trembling aspen, white birch, balsam poplar (Populus balsamifera L.), and rose (H. Hristienko, pers. com. 1985). The way that the twigs were severed verified whether the browser was an ungulate or a rabbit. Twigs browsed by ungulates have a ragged, torn appearance; rabbits make a clean, straight diagonal cut (Anderson, 1969; H. Hristienko, pers. com. 1985).

The plots were checked for pellet groups and browse after the snow had melted in April 1986. There was a late blizzard after that so plots were checked a second time. The plots were checked again in April 1987.

During the winter, within two or three days after a snowfall exceeding 2.5 cm (1 in), the transect lines were checked for fresh tracks. The directions of the animals' movements were recorded on maps of each site. Two characteristics of snow which can influence habitat use by ungulates, namely crust hardness and snow depth, were measured at ten sites in each area. Crust hardness was measured with

a crust gauge, and snow depth was determined from the 10 permanent meter sticks at each site. The readings were averaged to give general snow conditions. Ten surveys per winter was considered optimum (H. Hristienko, pers. com. 1985) but only three were completed the first winter (1985/86) due to resource limitations. Six surveys were completed during the winter of 1986/87.

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Veldhuis, Hugo. Department of Soils Science, University of Manitoba, Winnipeg, Manitoba. R3T 2N2.

# APPENDICES

## Appendix A

Data sheets used to record height, diameter and condition of the trees and shrubs in the vegetation macroplots.

Appendix A

C.M.J.F.H. PROGRAM - SANDY RIVER WEST

TREE DATA

PLOT: CREW: DATES:

| NO. | SPECIES | HEIGHT | DBH | CONDITION | | |
|---|---|---|---|---|---|---|
| | | | | JULY | SEPTEMBER | JULY |
| | | | | | | |
| | | | | | | |
| | | | | | |

Appendix A cont'd

C.M.J.F.H. PROGRAM - SANDY RIVER WEST

SHRUB DATA

PLOT: CREW: DATES:

| NO. | SPECIES | HEIGHT | DIAMETER | STEM COUNT | CONDITION | | |
|---|---|---|---|---|---|---|---|
| | | | | | JULY | SEPTEMBER | JULY |
| | | | | | | | |
| | | | | | | | |
| | | | | | | |

## Appendix B

Data sheet used to record cover, density and condition of herbaceous plants in the ten microplots at each study area.

Appendix B

C.M.J.F.H. PROGRAM - SANDY RIVER WEST

VASCULAR PLANT DATA

PLOT_____ MICROPLOT_____ CREW_____ DATES_____

| SPECIES | COVER | DENSITY | CONDITION | | |
|---|---|---|---|---|---|
| | | | JULY | SEPTEMBER | JULY |
| | | | | | |
| | | | | | |
| | | | | |

## Appendix C

Data sheet and transect maps used to record bird species.

Appendix C

C.M.J.T.H. PROGRAM - SANDY RIVER WEST

BIRD SURVEYS

Transect: _____ Time: _____ _____

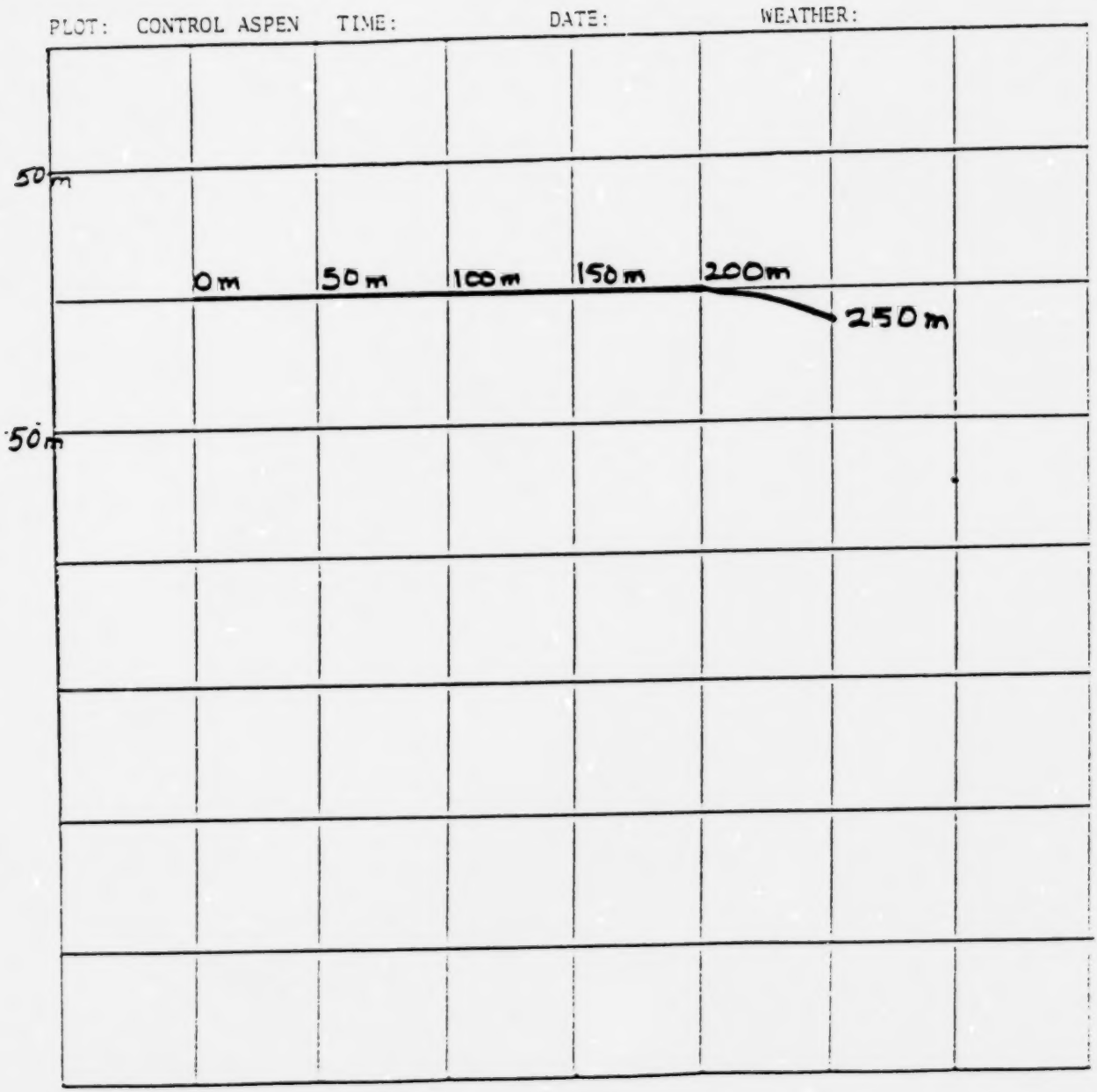
Date: _____ Wind Speed: _____

Observers: _____ Temperature: _____

_____ Weather: _____

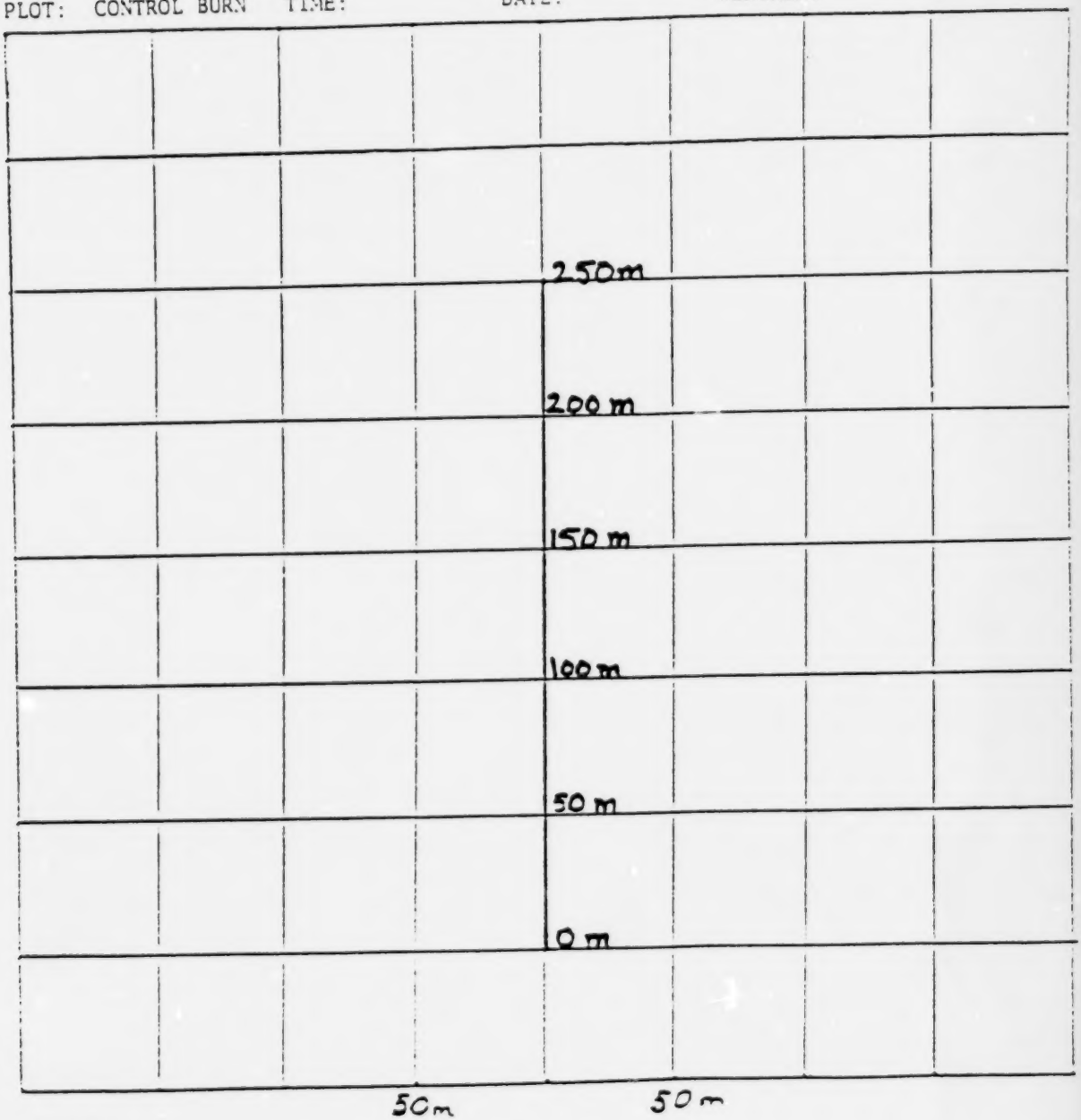
| BIRD NUMBER | SPECIES | NO. OF BIRDS | SEX | BEHAVIOUR | COMMENTS, ETC. |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |

Appendix C cont'd



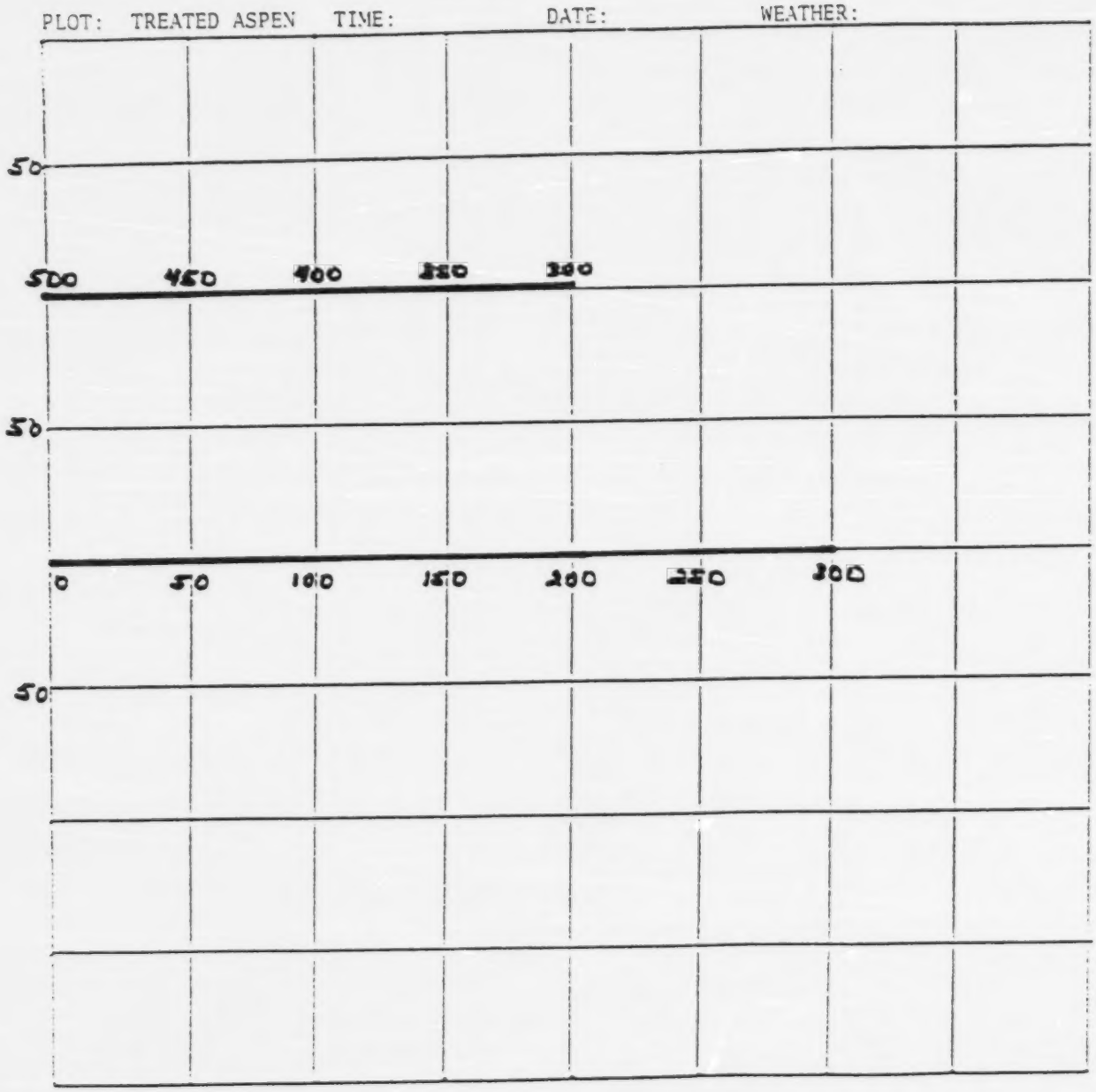
Appendix C cont'd

PLOT: CONTROL BURN TIME: DATE: WEATHER:




COMMENTS:

Appendix C cont'd

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Appendix C cont'd

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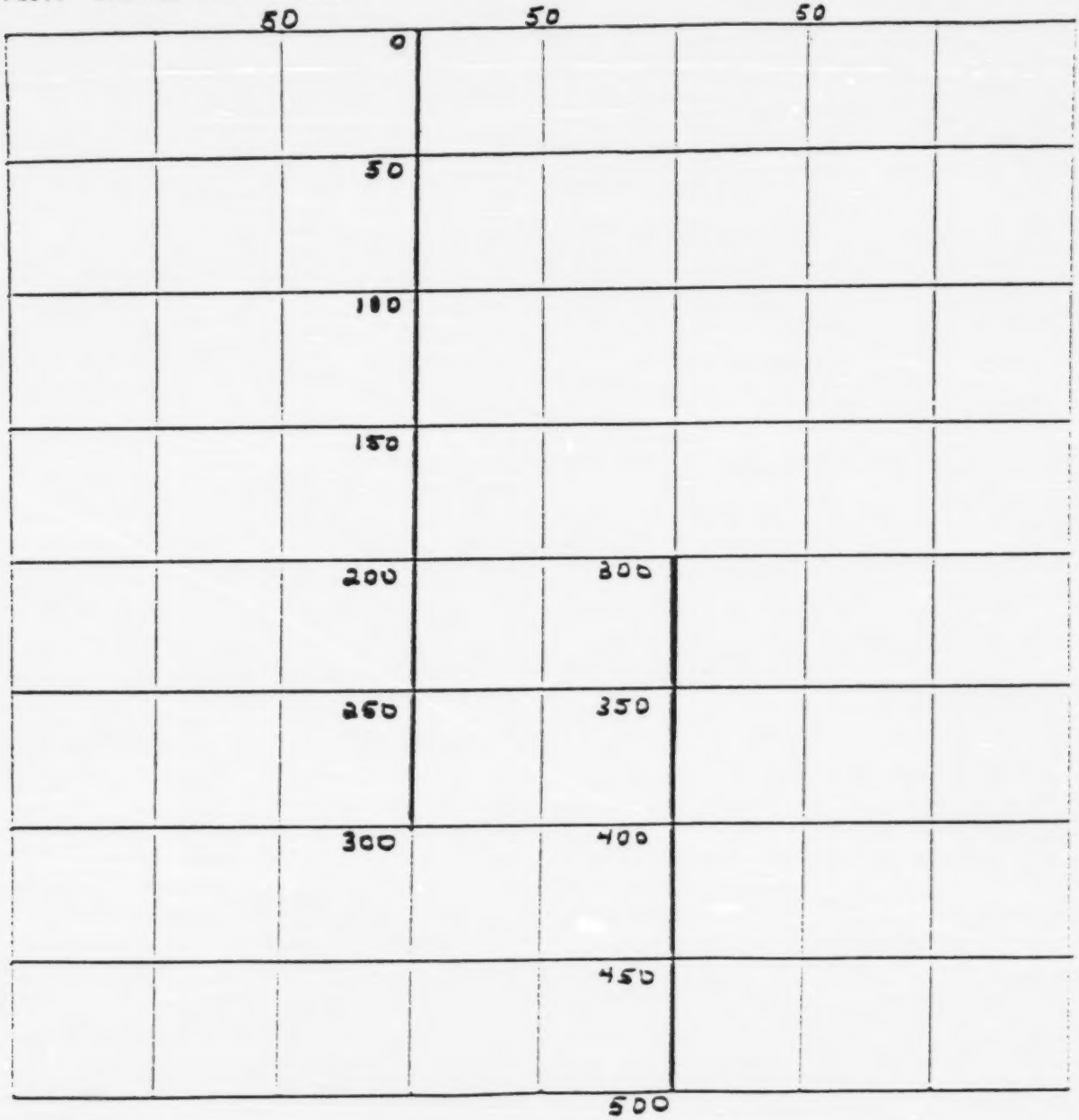



COMMENTS:

## Appendix D

Data sheet used to record the species of small mammals trapped at the four study areas.

Appendix D

FORESTRY HERBICIDE PROGRAM
SANDY RIVER WEST

SMALL MAMMAL TRAPPING DATA

PLOT NAME _____ DATE _____

| STATION # | SPECIES | SEX/AGE | COMMENTS |
|---|---|---|---|
| | | | |
| | | | |
| | | | |

## Appendix E

Data sheet to record browse and pellet groups found in each area.

Appendix E

U.M.J.F.H. PROGRAM - SANDY RIVER WEST

BROWSE AND PELLET GROUP STUDIES

Plot: Date: Crew:

| Miniplot Number | Vegetation Species | DBH | | Total # of Twigs | # of Browsed Twigs | | Pellet Groups Species | Numbers | |
|---|---|---|---|---|---|---|---|---|---|
| | | < | > | | Fall | Spring | | F | S |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | |

## Appendix F

Data and map sheets of each study area used during the winter surveys to record snow conditions, weather and ungulate movement.

Appendix F

C.M.J.F.H. PROGRAM - SANDY RIVER WEST

WINTER UNGULATE SURVEYS

PLOT: CONTROL ASPEN CREW: _____ DATE: _____

SNOW DEPTH: ____ ____ ____ ____ ____ ____ ____ ____ ____ ____

AVERAGE SNOW DEPTH: ____

CRUST: ____ ____ ____ ____ ____ ____ ____ ____ ____ ____

AVERAGE CRUST HARDNESS: ____

CRUST DEPTH: ____ ____ ____ ____ ____ ____ ____ ____ ____ ____

AVERAGE CRUST DEPTH: ____

TEMPERATURE: ____

MAJOR WEATHER DURING WEEK: _____

_____

_____

UNGULATE MOVEMENTS ARE ____ BY SNOW PACK.

TRACKS:

DEER

MOOSE

CODES

WEATHER TYPE:

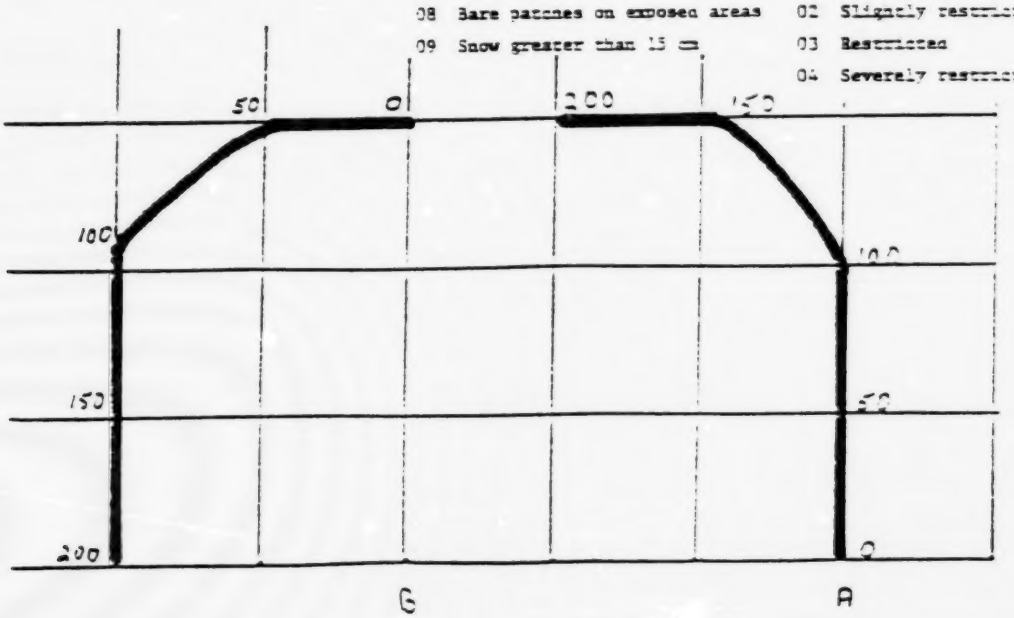
01 Extreme cold
02 Normal winter temperature
03 Windy
04 Blizzard
05 Melting
06 Crusting - doesn't support deer
07 Crusting - supports deer
08 Bare patches on exposed areas
09 Snow greater than 15 cm

CRUST:

01 No crust
02 Light crust
03 Strong enough to support man on snowshoes

DEER MOVEMENTS:

01 Unrestricted
02 Slightly restricted
03 Restricted
04 Severely restricted



Appendix F cont'd

C.M.J.F.H. PROGRAM - SANDY RIVER WEST

WINTER UNGULATE SURVEYS

PLOT: CONTROL BURN CREW: _____ DATE: _____

SNOW DEPTH: _____ _____ _____ _____ _____ _____ _____ _____ _____ _____

AVERAGE SNOW DEPTH: _____

CRUST: _____ _____ _____ _____ _____ _____ _____ _____ _____ _____

AVERAGE CRUST HARDNESS: _____

CRUST DEPTH: _____ _____ _____ _____ _____ _____ _____ _____ _____ _____

AVERAGE CRUST DEPTH: _____

TEMPERATURE: _____

MAJOR WEATHER DURING WEEK: _____

_____

_____

UNGULATE MOVEMENTS ARE _____ BY SNOW PACK.

TRACKS:

DEER

MOOSE

CODES

WEATHER TYPE:

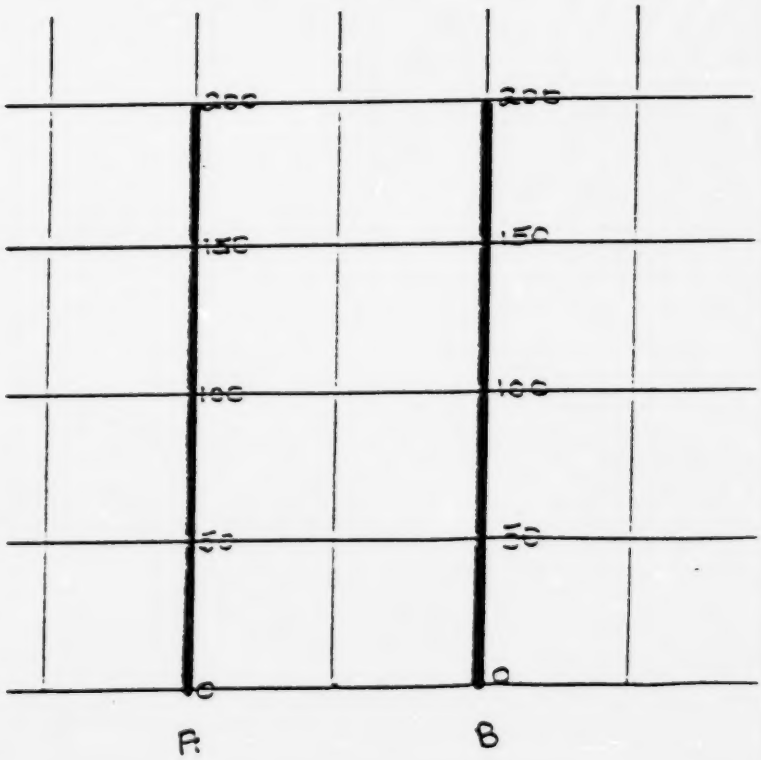
01 Extreme cold
02 Normal winter temperature
03 Windy
04 Blizzard
05 Melting
06 Crusting - doesn't support deer
07 Crusting - supports deer
08 Bare patches on exposed areas
09 Snow greater than 15 cm.

CRUST:

01 No crust
02 Light crust
03 Strong enough to support man on snowshoes

DEER MOVEMENTS:

01 Unrestricted
02 Slightly restricted
03 Restricted
04 Severely restricted



Appendix F cont'd

C.M.J.F.H. PROGRAM - SANDY RIVER WEST

WINTER UNGULATE SURVEYS

PLOT: TREATED ASPEN CREW: _____ DATE: _____

SNOW DEPTH: ____ ____ ____ ____ ____ ____ ____ ____ ____ ____

AVERAGE SNOW DEPTH: ____

CRUST: ____ ____ ____ ____ ____ ____ ____ ____ ____ ____

AVERAGE CRUST HARDNESS: ____

CRUST DEPTH: ____ ____ ____ ____ ____ ____ ____ ____ ____ ____

AVERAGE CRUST DEPTH: ____

TEMPERATURE: ____

MAJOR WEATHER DURING WEEK: _____

_____

_____

UNGULATE MOVEMENTS ARE _____ BY SNOW PACK.

TRACKS:

DEER

MOOSE

CODES

WEATHER TYPE:

01 Extreme cold
02 Normal winter temperature
03 Windy
04 Blizzard
05 Melting
06 Crusting - doesn't support deer
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08 Bare patches on exposed areas
09 Snow greater than 15 cm

CRUST:

01 No crust
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01 Unrestricted
02 Slightly restricted
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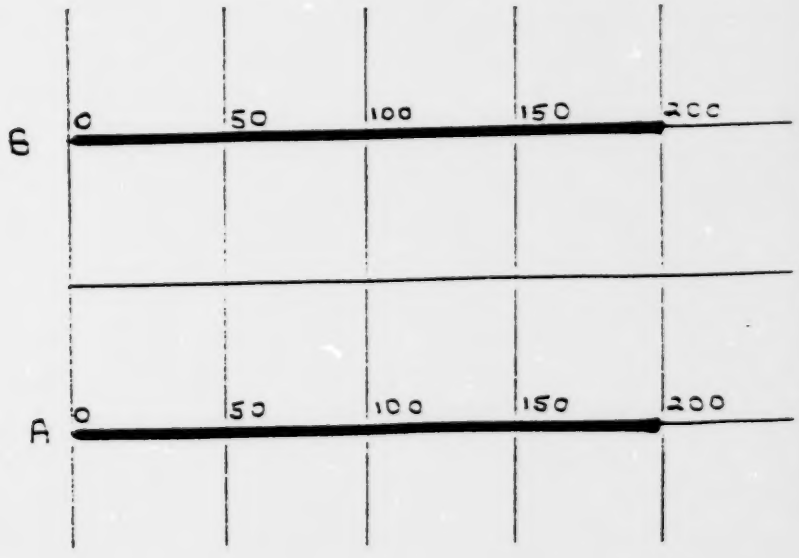

Appendix F cont'd

C.M.J.F.H. PROGRAM - SANDY RIVER WEST

WINTER UNGULATE SURVEYS

PLOT: TREATED BURN CREW: _____ DATE: _____

SNOW DEPTH: _____ _____ _____ _____ _____ _____ _____ _____ _____ _____

AVERAGE SNOW DEPTH: _____

CRUST: _____ _____ _____ _____ _____ _____ _____ _____ _____ _____

AVERAGE CRUST HARDNESS: _____

CRUST DEPTH: _____ _____ _____ _____ _____ _____ _____ _____ _____ _____

AVERAGE CRUST DEPTH: _____

TEMPERATURE: _____

MAJOR WEATHER DURING WEEK: _____

_____

_____

UNGULATE MOVEMENTS ARE _____ BY SNOW PACK.

TRACKS:

DEER

MOOSE

CODES

WEATHER TYPE:

01 Extreme cold
02 Normal winter temperature
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06 Crusting - doesn't support deer
07 Crusting - supports deer
08 Bare patches on exposed areas
09 Snow greater than 15 cm.

CRUST:

11 No crust
12 Light crust
13 Strong enough to support man on snowshoes

DEER MOVEMENTS:

21 Unrestricted
22 Slightly restricted
23 Restricted
24 Severely restricted